



### MARIJUANA EFFECTS ON ACTUAL DRIVING PERFORMANCE

Other than alcohol, marijuana is the drug that is found most frequently in crash-involved drivers. However, the extent to which marijuana impairs driver performance is open to question. One way to determine how marijuana is likely to impair driver performance is to study dosed subjects in actual on-road driving situations. A Dutch research institute, *Institute for Human Psychopharmacology; University of Limburg* carries out this type of drug research. The National Highway Traffic Safety Administration sponsored studies with this Institute to examine marijuana effects in the driving environment.

The Institute first carried out a pilot study to identify the marijuana doses recreational users are likely to consume before driving. This information was used to specify the dose levels for the individual studies. Volunteer subjects smoked marijuana cigarettes that contained predetermined amounts of  $\Delta 9$ THC (the primary psychoactive ingredient of marijuana) until they felt they had achieved their typical desired effect. The average dose required to attain this effect ( $300 \mu\text{g}$   $\Delta 9$ THC/kg body weight) was specified as the *high dose* condition. The *moderate dose* was specified as  $200 \mu\text{g}$   $\Delta 9$ THC/kg and the *low dose* as  $100 \mu\text{g}$   $\Delta 9$ THC/kg.

Both male and female subjects were recruited. Sample sizes ranged from 24 in Study 1 to 16 subjects in Studies 2 and 3. After subjects were dosed, they drove a dual-controlled instrumented vehicle along predetermined routes. For safety reasons, a licensed driving instructor, who could take control if an unsafe situation arose, rode along in the car.

The first study was conducted on a primary highway closed to other traffic. The purposes were to determine the effect of marijuana on certain aspects of driving performance in this closed course situation, and whether it would be safe to repeat the study on a normal highway in the presence of other traffic. After consuming marijuana, the subjects were asked

to drive at a constant speed for approximately 14 miles. Driving performance was measured by changes in lateral position in a traffic lane (a measure of road tracking ability) and average speed.

The second study was conducted on a primary highway in the presence of other traffic and involved similar driving tests as in the first study and a car following task. The purpose was to determine the effect of marijuana on certain aspects of driving performance in more realistic, but still relatively simple, driving situations. After consuming marijuana, the subjects were asked to drive for approximately 60 miles at a relatively constant speed, pass other traffic when necessary, and at predetermined intervals, respond to a lead vehicle driven by a member of the research staff (i.e., the driver was instructed to maintain constant headway with the lead vehicle). The driving performance measures were changes in lateral position in a traffic lane, average speed, and an assessment of headway maintenance ability for the car following task.

The third study was a 40 minute drive through urban traffic. For safety reasons, only the low marijuana dose was used. Also, for comparison purposes, a separate group of subjects performed the same urban drive after receiving an alcohol dose designed to achieve a .04 BAC. The purposes were to determine whether low doses of marijuana impair driver performance in more complex driving situations, and the degree to which this impairment is comparable to low dose alcohol impairment. For each subject, an overall assessment of driving performance was made using a standard rating scale. In addition, each driver was observed at predetermined points along the route to determine whether a correct response was made.

#### Results

**Study 1** Marijuana was found to have a significant impairing effect on the driver's ability to maintain a





steady lateral position within a traffic lane. The greater the marijuana dose, the greater the effect. Comparisons with similar alcohol research indicated that the marijuana effect was equivalent to the performance deterioration produced by BACs between .03 and .07. No marijuana effect was found for the speed maintenance task.

**Study 2** Marijuana's effect on road tracking ability was similar to that found in Study 1, with the exception that the low dose did not produce significant impairment in maintaining a steady lateral position within a lane. Marijuana was found to have little effect on speed maintenance and car following ability, except for the low dose car following situation. In this case, marijuana produced more cautious behavior as evidenced by an increase in the distance maintained between vehicles.

**Study 3** The low dose of marijuana had no effect on driving performance in the urban drive situation. On the other hand, the low dose of alcohol did appear to impair driver performance, specifically as related to vehicle handling and traffic maneuvers.

### **Conclusions**

Marijuana appears to have a negative impact on some driving tasks that are handled with little conscious control such as maintaining lane position, and this appears to be related to dose level. The conscious decision making activities that require more active information processing do not appear to be impacted by marijuana, at least at the doses studied. For these latter activities, drivers appear to compensate for any impairing effects by focusing more effort on the task at hand. This conclusion is supported by interviews with the test drivers who said that they felt the effect of the drug and correspondingly increased their atten-

tion and concentration. Whether drivers would be able to compensate for marijuana impairment in more complex traffic situations remains to be determined.

Although these findings imply that marijuana impairs less in some situations than others, they should not be construed to imply that marijuana is a safe drug. Marijuana is illegal, and produces driver performance impairment in some situations that may relate to crashes. It should also be noted that results from a recent crash study indicate that marijuana may increase impairment when combined with low doses of alcohol. NHTSA is currently planning additional joint research with the Netherlands to determine the nature and extent of this marijuana associated impairment.

Finally, it should be noted that this research is part of NHTSA's effort to identify the nature and magnitude of the drug problem. Other NHTSA problem identification research involves determining drug effects on driving performance in driving simulators, and crash studies to assess the frequency of occurrence of drugs in crash-involved drivers, and the extent to which they contribute to crash causation. Another major objective of the NHTSA drug research program is to develop and test procedures that enable police to identify drug-impaired drivers. For more information on NHTSA drug research, the results and policy implications of recent studies, and future research plans, see NHTSA *TRAFFIC TECH* No. 56, *Drugs in Crashes and Impaired Driving Arrests*, Dec. 1993.

For a copy of the report, *Marijuana And Actual Driving Performance*, or more information, contact Ted Anderson, Office of Program Development and Evaluation, NHTSA, NTS-30, 400 Seventh Street, S.W., Washington, DC 20590, (202) 366-5598, or send a fax to (202) 366-7096.

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